

FIELD BOOK

"Life in the Rain"

WEATHERPROOF



KEUFFEL & ESSER CO.

1-7-15-2

63-1

S/S

F

J. HICKEY
REV. 1
1963

CURVE FORMULAS

$T = R \tan \frac{1}{2} I$ $T = \frac{50 \tan \frac{1}{2} I}{\sin \frac{1}{2} D}$ $\sin \frac{1}{2} D = \frac{50}{R}$ $\sin \frac{1}{2} D = \frac{50 \tan \frac{1}{2} I}{T}$	$R = T \cot \frac{1}{2} I$ $R = \frac{50}{\sin \frac{1}{2} D}$ $E = R \text{ ex. sec } \frac{1}{2} I$ $E = T \tan \frac{1}{4} I$	$\text{Chord def.} = \frac{\text{chord}^2}{R}$ $\text{No. chords} = \frac{I}{D}$ $\text{Tan. def.} = \frac{1}{2} \text{ chord def.}$
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The square of any distance, divided by twice the radius, will equal the distance from tangent to curve, very nearly.

To find angle for a given distance and deflection.

Rule 1. Multiply the given distance by .01745 (def. for 1° for 1 ft.) and divide given deflection by the product.

Rule 2. Multiply given deflection by 57.3, and divide the product by the given distance.

To find deflection for a given angle and distance. Multiply the angle by .01745, and the product by the distance.

GENERAL DATA

RIGHT ANGLE TRIANGLES. Square the altitude, divide by twice the base. Add quotient to base for hypotenuse.

Given Base 100, Alt. $10.10^2 \div 200 = .5$. $100 + .5 = 100.5$ hyp.

Given Hyp. 100, Alt. $25.25^2 \div 200 = 3.125$. $100 - 3.125 = 96.875 = \text{Base}$.

Error in first example, .002; in last, .045.

To find Tons of Rail in one mile of track: multiply weight per yard by 11, and divide by 7.

LEVELING. The correction for curvature and refraction, in feet and decimals of feet is equal to $0.574 d^2$, where d is the distance in miles. The correction for curvature alone is closely, $\frac{1}{3} d^2$. The combined correction is negative.

PROBABLE ERROR. If d_1, d_2, d_3 , etc. are the discrepancies of various results from the mean, and if $\sum d^2$ = the sum of the squares of these differences and n = the number of observations, then the probable error of the mean = $\pm 0.6745 \sqrt{\frac{\sum d^2}{n(n-1)}}$

MINUTES IN DECIMALS OF A DEGREE

1'	.0167	11'	.1833	21'	.3500	31'	.5167	41'	.6833	51'	.8500
2	.0333	12	.2000	22	.3667	32	.5333	42	.7000	52	.8667
3	.0500	13	.2167	23	.3833	33	.5500	43	.7167	53	.8833
4	.0667	14	.2333	24	.4000	34	.5667	44	.7333	54	.9000
5	.0833	15	.2500	25	.4167	35	.5833	45	.7500	55	.9167
6	.1000	16	.2667	26	.4333	36	.6000	46	.7667	56	.9333
7	.1167	17	.2833	27	.4500	37	.6167	47	.7833	57	.9500
8	.1333	18	.3000	28	.4667	38	.6333	48	.8000	58	.9667
9	.1500	19	.3167	29	.4833	39	.6500	49	.8167	59	.9833
10	.1667	20	.3333	30	.5000	40	.6667	50	.8333	60	1.0000

INCHES IN DECIMALS OF A FOOT

1-16	3-32	$\frac{1}{8}$	3-16	$\frac{1}{4}$	5-16	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$
.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0417	.0521	.0625	.0729
1	2	3	4	5	6	7	8	9	10	11
.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167

✓
Locality 1.

White Butte. SW $\frac{1}{4}$ Sec 20
T 139 N R 97 W

Plant fossils in grey
shale above (below?)
HS layer

Talley Taken June 29, 1963
Specimens of lettered Types
returned

Type	6/29	To Dom	Type	6/29
------	------	--------	------	------

A	45		Banana l.	3
---	----	--	-----------	---

B	57		P	5
---	----	--	---	---

C	2		Q	1
---	---	--	---	---

D	22		R	1
---	----	--	---	---

E	2		Lygodium	1
---	---	--	----------	---

F	1			
---	---	--	--	--

G	9			
---	---	--	--	--

H	21			
---	----	--	--	--

J	1			
---	---	--	--	--

Salvinia	8			
----------	---	--	--	--

Large magnolia	28			
----------------	----	--	--	--

K	4			
---	---	--	--	--

L	2			
---	---	--	--	--

M	2			
---	---	--	--	--

O	1			
---	---	--	--	--

Dicer.

NW $\frac{1}{4}$ Sec 8: T. 143N R. 90W

Loc. 2.

S10 $\frac{1}{4}$ Sec 5



Mica Upper Mbr

MICACEOUS SS.

ALTERNATING layers of
dirty, COARSE MICACEOUS SS
1 finer lighter greyish yellow
MICACEOUS SS.

Benson's Upper Mbr(?)

Sp. 2-1

2-2

2-3

2-4

SEP. 33

Loc. 3. X

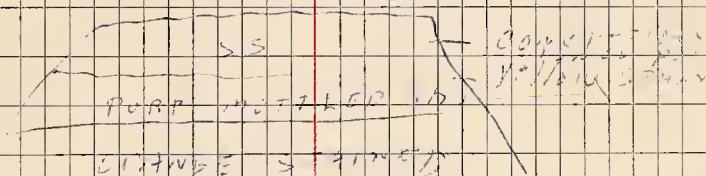
Butte abt 50' high.

Orange stained strat
bottom

Grey plant & unio. str.
at middle

Gravelly up into ss
which forms cap.

Spec. 3-1 - UNIO



Locality 4. X

BUTTE TO S.E. of first.

UNIO & LEAVES

Just above orange

CONCRETIONARY X

HORIZON

Spec 4-1 - UNIO

4-4 - sequoia 4-2 - LAURUS LEAVES
4-3 - leaf.

Loc. ~~X~~

Loc. 5 NE 1/4 Sec 2 T143N R9W

~~measured~~ section Loc of
Benson

~~No section evident~~

~~Channel of JS~~

~~about 1/2 mi in length~~

~~Trailing up F.W.~~

Loc. 6.

Benson

Loc 6. SE $\frac{1}{4}$ SE $\frac{1}{4}$

Sec 10 T 142N R 88W

TYPE 4A ORANGE

1.

Mudstone clay overlain

by fine grained sand

micaceous ripple marked

unio in grey shale

above the orange

marker bed

JM
— 20 —
— lignite — A.B. eq.
— brown sh — VL

— calcareous sandstone
— grey sh
— orange sh
MO

24-1

~~ANALYSIS~~

BANKS of Heart River

CONTACT of ~~FT~~ UNION
ENV. 2

*member interform
disconf*

Loc 24-1 at ~~SE 1/4~~ SECS

NE 1/4, NE 1/4 SEC 11

T 139 N R 66 W

JUNE 24.
NCCG-24-2

1. ✓

NE 1/4 NE 1/4 sec 17
S 1/2 1/4 S 1/2 1/4 sec 17
T 139N R. 96W

Fossil local in Grey sh.
abt. $\frac{1}{3}$ way down cliff

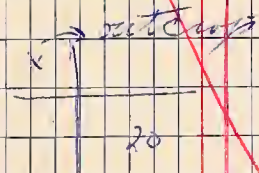
24-3. ~~NE 1/4 NW 1/4~~
~~sec 17.~~

~~T 139N R 96W~~

~~Clay pits of D.K. - 100A~~
~~Clay pits~~

~~Any clay in pit no fossils~~

24-4. Butte in NW 1/4 of
sect. 20 T 139N R 96W



Very cross bedded at top.

June 24 ✓
14-5 Center Section 23
T139N R96W

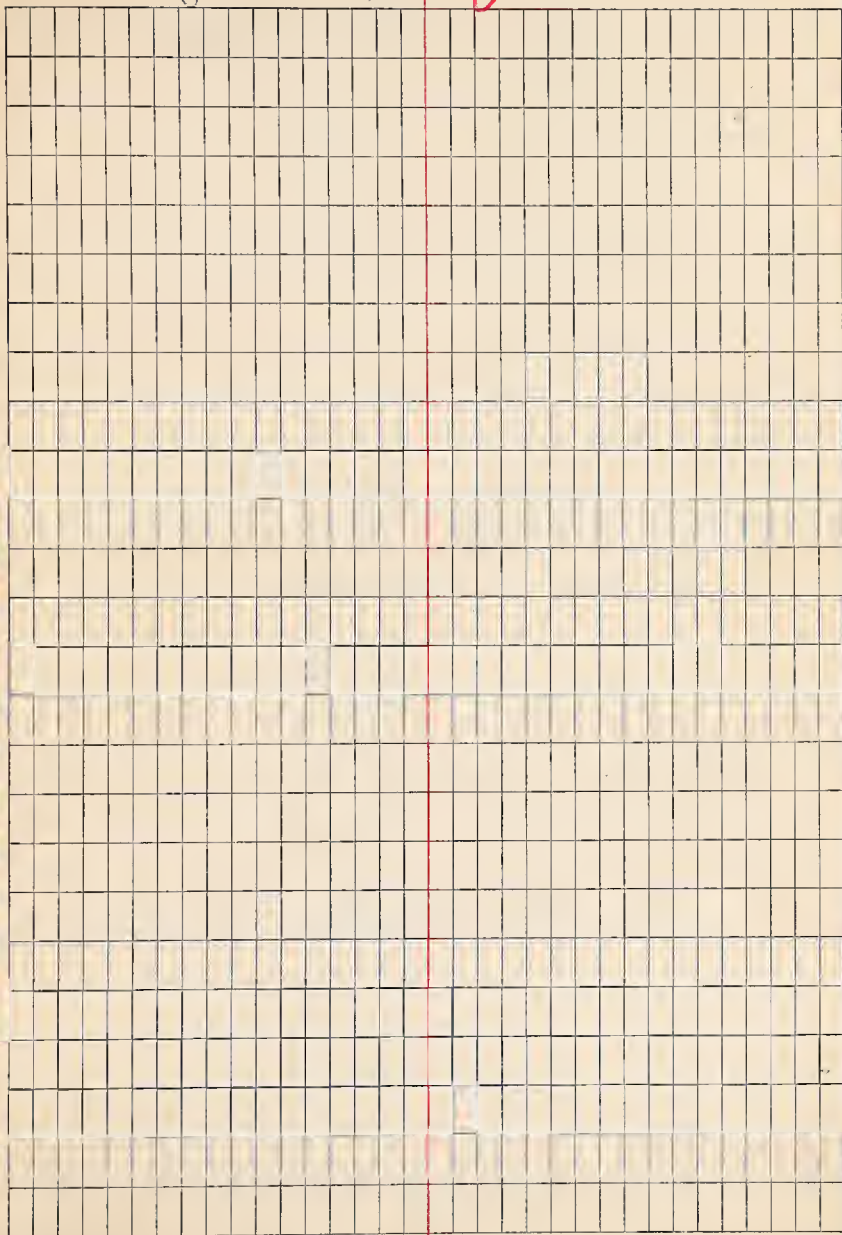
Quarry in SW

bedded upper mbr.

Davis Butte.

Houston Middle.

JUNE 25



Loc. 7-1-1 & 9 (6-24-1)

July 1. The Koestler Section.

~~SE 1/4 SP 1/4 Sec 18~~

T 139 N R 96 W

NE 1/4 NE 1/4 sec 17

Thickness Elev above

Hart R.

6'

Section starts.

1.75

7.75

very dark grey
fine grained clayey
sand with some
lignified wood frags.
& limonite stained
JOINT ^{fractures} PATTERNS

0.45'

8.2

Very dark grey
very fine grained
clayey sand with
limonite JOINT
PATTERNS some
lignified wood
present

1.8'

10'

Rusty grey fine clayey
sand ~~grading upward~~
to

0.85' 10.85' Lignite Black easily
split. somewhat sandy
Base of lignite stratus
sand with limonite
for about 2"

2" clay parting at
top of Lignite
(Conc. from sh. in lig.) Sample

Sample 6-24-1-1

1.25' 12.1' Grey shale very somewhat
fissile limonite stained

3.3' 15.4' Lignite

0.45' 15.85' Dark grey clay shale
with ~~greenish~~ by limonite
stained concs. in its
upper edge and
lignite wood
fragments.

leaf found on one
conc

Spec. →

7-1-1-2 & 7-1-1-3

7-1-1

Th.

22.5'

7.6'

2.5'

to

to

10.6'

26.

A dark grey unit
beginning above
the clay with a
layer of conchs.
& lignified wood
frags.

lignified wood
becoming scarcer
in first 1 foot.
Scattered marcusite
nodules

Unit begins as a
silty clay in first
2' then a
silty fine grained
sand - (dark grey)
A

Some shale stringers
top 2 feet

Becomes finer grained
and more clayey -
toward top.

finally a ~~sidark~~
grey silty clay

7-1-1

Lower 2.5 feet are
a silty ^{dark tan} grey clay
grading upward into
a f. f. f. ss.
grading upward into
a v. f. silty ss & clay
(dark grey) with
a few shale string-
ers.

Some s. y. wood at
base of fm. Rare
marcusite cones
(limonite staining)

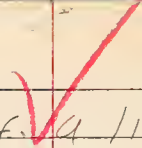
22.5' unconf. conc. ss.
but elsewhere or up to
26 becomes a shale

The undisturbed shale zone
with some limonite cones

7.0 22.5 Unconf. at least 5' of
Relief on it.

marked by a conc. layer
(limonite) and a change
in out crop color from
dark grey to tan

7-1-1

on uncf.  a limonite
stained ss with
concs. of limonite.

26'

Unconf. overlain by
a limonite conc layer
of ss.

Color of shale beneath
is grey - Cliff becomes
more vertical & buff
colored

4.6'

Buff limonite stained
sub rounded medium
ss intensely stained
with limonite at
contact much less
so upward ^{at base} ~~buff~~
Qtz & abt 5% dark
minerals.

Clay blebs (light grey
through bl) Very rotten
included in the sand
in first 2 feet
carry plant fossils &
shells.

samples →

7-1-1

Samp. 7-1-1-4 - fossils from
Clay

7-1-1-5 - FT Union
shale below unconf
by 1'

7-1-1-6 - Sand above
unconf

Bedding of sand not
evident.

few mica flakes
Some ~~to~~ small 1-2"
limonite cones
limonite vein
fillings

3.4 30.6

Bedding of ss becomes
evident often marked
by seam of limonite.
Sand buff med sized sub
rounded, limonite
~~joint~~
fillings.

Many small 2-3 mm
limonite cemented
sand blebs.

Bedding mostly II.

Pull 4 33 34 39 42 45-48-51
7-1-1

42.5'

34'

Cross bedded,

rounded
Subangular

buff ss

<10% feldspar

limonite on bedding

planes & joints

Some seams of lignite

scattered 1-2 in. &

less / little lateral

continuity.

Some

limonite concs

scattered.

clay blebs in

& beds

Fe₂O₃

clay

Very little in joints.

>10% Dark minerals

Between 5-7% Darker

Scattered mica flakes

.25 mm

Occasional little less
obviously bedded

PULLED 57-57-60-63-68-69-70
7-1-1

Bird shot 11 monite Breeds
1-3 mm through out
at 58 feet. X bedding
becomes less evident

last clay blocks at abt.

Feldspar 3-4%

Feldspar 3-4%

Jointing very strong
at 62 feet

weathered color becomes
whitish.

at 72' Limonite cones
somewhat more numerous
carrying abt 15% clay

at 75' - abt 20-25% clay
whiter weathering
no obvious bedding
abt 2% lithic frags
+ 2% mica at 76'
10% Feldspar

7-1-1

9.5

76.5'

Fine grained Lt. grey weathering

Arkosic ss. 3-5%

Some mica 5-10%

With purmaroon & carbonaceous

partings about 1/2"

Some limonite on

partings.

car some clay or silt

abt. 77' fine grained

light grey weathering

sandstone with abt

25-40% clay.

partings 1/2 to 1 in

mica flakes 5-7%

Arkosic.

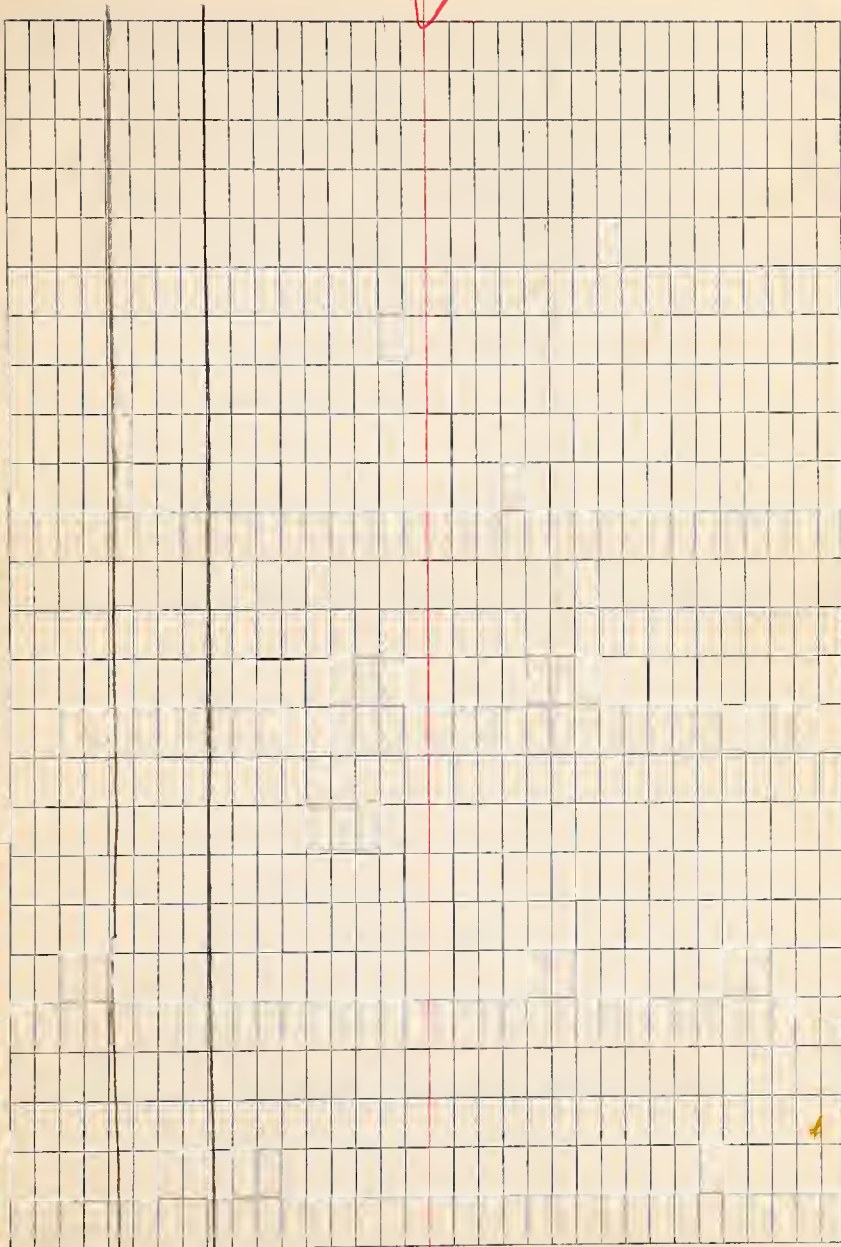
80'- White weathering

Very fine sand with

almost = silt & clay

86

End of silty vf sand
Soil Cap.



Loc. 7-2-1 Offset of sec. 7-1-1

180 feet from Pt. B. 1



Height. Buff med. g. sand sub
angular salt & pepper
sand with some limonite
staining at 2'
abt 10% Clay
10% Dark minerals
5% feldspar
At about 2.5' becomes
whiter weathering
3'
Sub ang. buff. limonite
stained medium sand
w/ly mod indurated
15-20% Clay
15-20% (f) or (kaol.)
7% Dark. min.
Lith Sample (3')

7-2-1-1-3 feet

7-2-1-2-6 feet.

6' Lith. Sample (7-2-1-3)
fine sand - buff. limonite
stained

20-25% Clay
Scattered Carbon trash.

0-3-6

7-2-1

Heavy Carbon Trash

Blotching top 2 in.

White weathering

A few mica flecks abt

2 ft below C.T.

1.1 6.6' - Carbon Trash Unit.

11 vfg. ss & clay

5-7% dark min.

Unit has numerous partings
of bedding planes 1/8-1 in.
covered with Carbon Trash
colored black & maroon.~~1-2% mica~~11.3 7.7' A vfg. - light grey very
clay rich - (40-50%)

Unit with few

obvious bedding &
occasional partings
yielding splashes of
Carbon Trash. Mica 2-3%

Dark min 2-4%

11' - Flaky partings in

vfg. s. & clay 50-50%

Covered with Carbon Trash

12' - More massive light

Still C.T. 150-50 vfg. s.

mica 2-3%

clay

9. 2-15-10.

7-2-1



15' Pretty much same unit
limonite & carbon trash
un bedding. Layer
mica flakes conc in
partings. mica abt 2-3%
by wt. 50%

15.5' A clay or silt con.
with a med sand
sub angular sand
white weathering
mica abt - 1%

18' med sand with 40-60%
clay white weathering
limonite stained brown
occasional conc of
limonite stringer
parting continues

18.5. weathered conc

19.0 19.0 soil

July 15, 1963

SECTION 7-15-1

Clay Pit.

Sec

T 14N R

W.

H. T. Ft. Union.

0. Very light grey siltstone
with purplish brown
channels of siltstone - 2-4 in.
medium, angular strings
of sand & lignite
nervises

Some lignite pieces
steeply dipping bedding
present.

3.2

Channel at 3.4'

Strike 117° Dip 15° N.

Lignites with some gyp.
Lignites in channel
set by abt 6 in of
ss + siltstone

5' Brownish grey
chippy clayey siltstone
plant frags.

9' DITTO 5' - Plant frags.

Some lignite cemented
sand cones

Loc 7-2-2

Sec 7-2-2 ✓

18'

0'

Buff - med g. sub ang.
sandstone. Birdshot

obscurely x bedded

Dark min 7-10%

3' - less than 1

obscurely x bedded

75 Carbon trash on
crossbeds

X bedding very not clear

Scattered large 5-8'

limonite zones

above 6' becomes

somewhat more

white weathering

Ht 9' - carries 2-3% mica

At 12' - Xbeds continue

mica 1%

scattered cones

Bird shot out at 6'

15' fine grained

still x bedded

C. thin sh. mica 1%

2'

18'

partly

Clay stringers in a

fine g. buff with some

carb trash & limonite

2' thin

7-2-2

Sand grades INTO



3' 20' MOTTLED GREY & Y/FE
yellow Gypsiferous
silty clay.
Surface covered with
Polygonal shrinkage
cracks & small Gypsum
x/l
Scattered frags. of lignite
wood.
Top of Clay becomes steadily
more silty & sandy
more limonite stained

2' 23' light grey f to v. f. ss
sub angular sand
3 to 6 in. clayey sand
5 to 8 in.

24' Darker grey v. f. sand
DN. 5' Carbon Trash on partings

25' Carbon Trash ss.
fine - to v. f. silty sand
8 to 10 Dark min
5-7 to 10 in.

Partings 1/8 in some limonite

7-2-2

2.5

STAINING

Appears somewhat
darker grey & STEP like
in outcrop

4.5

27.5

light grey fine grained
sub angular clayey or
silty limonite streaked
sand stone. Appears
massive ~~10~~ foot
becomes very clayey
with stringers
grey ^{clay} mottled by
~~mottled~~ limonite
somewhere vfg

17.5

31.5

Dark grey ~~plastic~~
clay stone mottled
by limonite
In outcrop covered by
polygonal shrinkage
cracks.

interior light grey
with limonite in
joint fillings.

34 slightly silty
more bedded somewhat
lighter grey

7-2-2

35' light grey siltstone
with gypsum.
extensive limonite staining

36 silty shale (light grey)
Leaves found here &
1 foot below
Cercidophyllum
arcticum

Leaf loc. 7-3-1
Specs. 7-2-2-1 & 2

37- ~~Siltstone~~.
silty sh. light grey

37.5 ~~shale~~ claystone
limonite staining

38.- Gypsum.

39- light grey limonite
stained silty shale.
Some gypsum.

40- more shaly block
shale

7-2-2

6850 m not part 41

41 light grey clayey

siltstone 100%

limonite stained

42 DITTO

Color change to
very light grey

above 42 siltstone

color change ver. nitrous

43 - Very light grey

siltstone with small

mottles of limonite.

45 - DITTO (43) with

limonite vein fills.

48 - DITTO 45)

49' 49 - Section capped

by very hard silicified

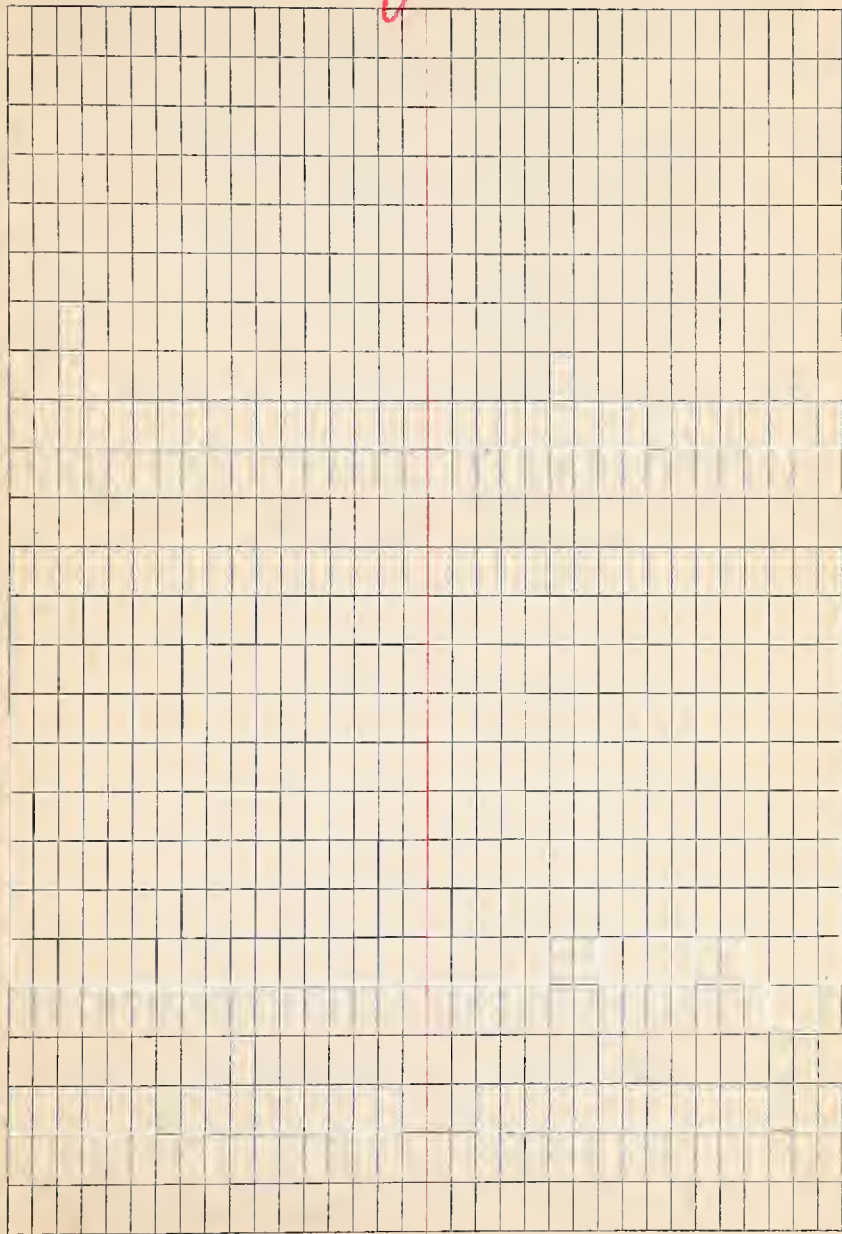
siltstone (white) not

porcelainous)

→ Lith sample

7-2-2-3

7-2-2-4



LINE 3

Localities 7-3-1

36' level of sect. 7-2-2

Cercidophyllum

+

Populus leucocarpa

July 5 - Little Banded

6 mi S of S. Hart

South of Dixie July 6 - 1963 Sect 7-6-1

Thickness:

Section 7-6-1 (D.S.)

from 7-2-2

2

1

20.8

Buff & light grey, med g
sub ang. friable, massive
slightly silty or clayey
sandstone. Feldspar
5-10% - Dark min. 7% - 4%
Scattered lumenize blotches

Feldspar = (1/2 x 1/2)

12' becomes fine grained
sub angular

silt about 10-15% 50%

12 feet Bedding becomes
obvious

Carbon Traces in Bedding

Bedding very localized

15' No Bedding sandstone
same as 0-12'

16' increase of silt
becomes fine last 1'

20.8

3.2

Maroon marker bed.

fine g. - purple grey

weathering ss. with

80% silt-clay. Closely spaced

7-6-1

JUNY-6
Thickness H.

partings covered with
Black & maroon trash

23' Marker bed of SILTSTONE

23.5' SILTSTONE - vfy
sandstone MICA 2-370
C.T. in beds.

3.5 24' Sandstone
Buff to grey sub-ang
med. grained silty-clay
60-257.7 ss
weathers light grey

2 27.5 Dark grey - grey
weathering slightly
silty clay or shale
fossil leaf
layer shale & clay
Some limonite staining
elsewhere Wh surface displays
numerous rounded
rock ss.

in pink 29.5' Grey siltstone
33.5' Silty clay
shale light grey

7-6-1

SILTY CLAY

17. 36. Siltstone becomes
very light grey to
white. Some limonite
staining.

39. Limonite in some
joints. Slightly silty
white clay

42. DITTO 39

44. Darker grey slightly
silty clayrock

2 45.5 Silicified siltstone-clay
caprock white bedded
& jointed somewhat
limonite stained.

47.5 Soil Happens.
c' soil.

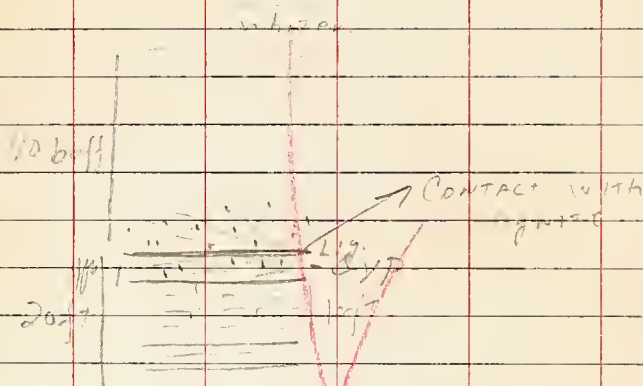
Locality 7-6T-2

400 feet N. East of 7-2-2.

along Heart River.

Silty grey clay F.T. Union
with 4 lignite beds.

Here the Buff-med grained
cross bedded SS lies
directly on the top lignite
of the F.T. Union.



Contact med grained buff
grey sand with Carbonaceous
beds. 1 ft thick
Contact + lignite staining

Loc 7-6-2 ~~Contd~~

~~shale blebs above contact of
Buff SS 1-1-1 Union 1/2-1-1~~

~~Sec 7-2-2~~

~~3830 ft~~

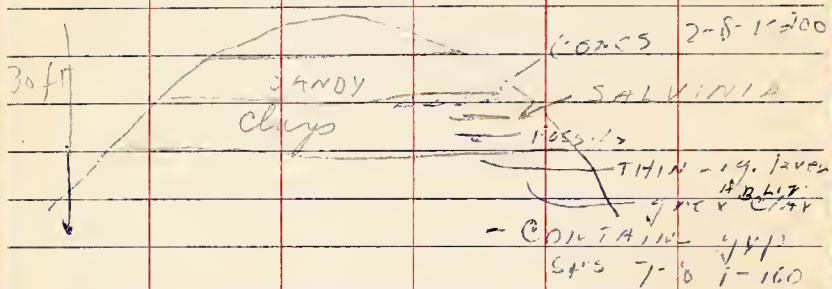
~~from Sec 7-1-1~~ ft

July 8, 1963



LOC 7-8-1

SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec 4 T140N R90W



Exposes section of Golden Valley fm
about 10 ft. above SS layer.

fossils found in yellow (1.5 in wide)
grey clays just above a
1" grey clay with a lignite
layer 1/2" on top of it

Fossil clay about 2.5" thick
capped with a layer of hematite
stained concs. Hematite concs
abundant about 6" above base of
foss clay.

Overlain by 10 feet of
bedded yellow sandy silty sand.

July 9, 1963

Section at locality

(7-8-1)

Called 7-9-2

loc. 7-9-1. Abt 20 feet lower
than loc 7-8-1 in a baked
clay & siltstone sequence
below a scoria.

Section 7-9-2

SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 4 T40N R9W

H.	TH	UNIT
0		Bottom of lower quarry floor
3.5	3.5	Covered
↓	1.5	Baked red & orange shale with ~~Equisetum~~ & Saguaris(?) frags
4.5	2	White Baked shale with "chink" texture & carrying "maple" leaves & Sequoia(?) LIGNITE & manganese stained joints

Sec. 7-9-2 CONTD

H	T	
6.5	4.5	White fine grained s carrying abt. 40% clay with hematite stained joints & ~~also~~ bedding. Bedding abt 1-1 1/2"
11	2.5	11' becomes highly fractured & TAN with HEMATITE staining with stringers of black & 13' dark ^{gray} green linker through it. very fine grained but ~~very~~ CRITTY with vugs of HEMATITE & through it.
13.5	1	Scoria or cinder layer - vesicular block slag with red stain - 33 in. x 5
14.5	3.5	Rubble zone mostly covered
18.		Covered but 9-10' below

7-9-2.



H T

15 Unbaked analogue of
Clays with fossils.
Carr Maple. Sphenoc
fern

Secondary section

13.7 1.3 Fine grained S.A. micaceous
2-37. light grey slightly
minutely laminated
claystone with about 25%

Clay

15 2.5 Covered

17.5 1 Grey clay with carb
blebs

18.5 0.5 White & Grey mottled
clay

19 7 Partly silty white
clay rock with carb
blebs

or silty clay rock

22 Begins picking up minute
(siderite?) blebs

23 Grey silty clay rock

26 0.2 2" Carb blebs, purple
appearing layer

7-9-2



26.2'	~~0.4~~	lighter grey clay with limonite pellets 1 joint staining turns dark ^{purplish} grey in last 8" before top contact,
29.6	0.15	1" lignite
29.75	0.25	TAN, limonite stained very fossiliferous (leaves) shale Book leaf shale.
30.1	0.4	1.4' limonite stained silt concretions sometimes hematite & manganese stained
30.4	1.6	yellowish grey fossil leaf clay
32	0.9	purplish, brown, fissile limonite stained fossil to foot 20' + SWAMP clay carbonaceous matter & bright yellow (feld) mineral

SALT

7-9-2.



- 32.9 1.6 Buff, limonite STAINED
siltstone, containing
monocot wood scraps
typ. on bedding planes
lower foot.
- 33.9 Vfg ss bedded abt
3"
heavily limonite STAINED
1-2% mica flecks.
- 34.5 2.5 well indurated, fine grained
buff-tan micaceous
(2-3%) ss with swirled
bedding
- 37 6.5 Buff f.g. micaceous (4-5%)
unindurated unbedded s.
occasional limonite staining
- 43.5 2.5 Purple siltstone-clay
banded with limonite
- 46 1.5 6" + lignite - 1" layer
of bright yellow ferrim
- 41.5 4.5 Purple siltstone
chocolate brown unit.

7-9-2



49. - 49.5 limonite
STAINED silt.

Purple Clay with
heavy limonite
blotching

MANY limonite
conc frags in slope
weathering.

55

7

Vfg ss - buff
limonite STAINING.

covered

62.

1.3

limonite colored
fine grained
micaceous (1-2%)
ss. Somewhat bedded
some ripple marks
fairly well indurated.
Coal.

July 9.

LOQ 7-9-1

fossils

from baked shale below
SCORIA 7-9-1-1

from clay below analog 7
7-9-3

LOCALITY 7-9-4

1 1/2 mi N.W. of sec-9-2

into section 5 T140N R. 90W.

Top of G.V. Divide

All covered

buff fine g. micaceous
s.s. sandstone with
lentic blocks 2 mm.

LOCALITY 7-9-5

Clay pit.

NE 1/4 SE 1/4 Sec 5 T140N R. 90W.

Shows part of same section
as section 7-9-2

July 10

Loc 7-10-1

Fossils from dark gray
clay at elev 27.5 of Sec.

7-6-1

7-10-2 Wh Butte.

July 11 Loc. 7-11-1

Top of DAVIS BUTTE

SE $\frac{1}{4}$ Sec 24 T140N R96W

Well indurated buff ss with
fine grained texture & 12 mica.
abt 3 ft exposed at top of Butte
in pit on N.E. side.

2 or 3 in by 3 feet of x bedded
med gr ss with abt 15%

Feldspar 37% DARK min.

Mica in bedding planes.

Loc. 7-11-2 - Rocky Butte in Dickinson

Moderately indurated Reddish
buff fine gr ss. limonite
plotted ss. Capping Rocky
Butte

SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec 33 T140N R96W

✓
Loc 7-11-3 N end of Rocky
Butte.

1
P.T. exposes about 10 feet of
SS. Composed of alternating
ledges of indurated bedded &
unindurated bedded buff ss
alternations about 2 ft. thick

Loc 7-11-4

SW $\frac{1}{4}$ SEC 7 T 140N R 95W
SE $\frac{1}{4}$ SEC 12 T 140N R 92W

Along road exposures of
typically light grey & orange
weathering G.V. silty clays

Loc 7-11-5

Center of line between secs.

7 & 8 T 140N R 95W

G.V. silty clays Orange colored

Loc 7-11-6

SE $\frac{1}{4}$ SE $\frac{1}{4}$ SEC 6 T 140N R 92W

About 40 ft. of yellow^{ish} Golden
Valley ss mostly unindurated
v.f.g. very clay rich & micaceous

3-570 ~~in~~

with

occasional imp. of Harder
limonite stained more indurated
SS & zones of weathered limonite-
goethite cores. Little resistance
to weathering forms slope

Overlain by about 50 ft. of Harder
well indurated arg to s.s. med
SS with abt 5% mica & 4-7.
Dark minerals. Some 1-2" bedding
evident & limonite staining in
bedding.

Cross bedding in small scale
within larger 1'

7-11-7

G.V.

Sequence of grey weathering
frequently limonitic

very silty SS. Much clay

some limonite "B" blt

→ frequent indurifiable

forming in a greyer clay

just above

✓
H' Sequence of

2' grey porous rock

3' Hard iron yellow

Siltstone cap exp.

Hard yellow siltstone

spec.
7-11-7

porous, grey, silicified
layer

white or light grey vfg clayey ss

limonite nodules

uncorr. (limonite)

Buff grey wh.

grey clay

LOC 7-11-7

NE 1/4 NW 1/4 SEC 5 T140N R 15E

Golden Valley Sequence

a light grey somewhat buff ss (3ft)
covered by a limonitic zone (1")

followed by 1 to 1 1/2' of Grey clay
with frequent plant frags

followed by abt 10' of white

somewhat micaceous (2-3%) vfg
clayey ss with frags of

bubble corals scattered in it.

✓
capped by a 2' of
grey silty clay
then covered by 2' of
Hard yellow siltstone
then 2' of very good brown clay

Watched a dragonfly trapped in
water dropped on by a turtle

Loc 7-11-8

SE 1/4 Sec 19 T14N R 95W

20' Grey, brownish weathering
silty fine to medium
crossbedded ss with thin
stained bedding. ~~Calculation~~
plant remains - ~~Calculation~~ 25'
impression

Believed to be Green River
terrace material

July 12, 1963

Section 7-12-1

H ~~NE 1/4~~ SW 1/4 sec 4 T140N R 90W

0 12.5 Brownish grey - light grey &
limonite weathering
clayey siltstone

Some worm tubules appear
present.

1' - mottled dark Br & light grey

5' - light grey to wh

6' - wh or v. l. grey siltstone

rich 1/2 to 1

Minute blebbles (.5 to 1 mm)

of limonite-goethite
present in rock, slope wash.

7.5 - light grey siltstone
with clay. Blebbles cont.

10' Clayey siltstone l. grey
some limonite staining

Blebbles (.25 mm - 5 mm)

11.5 Siltstone turned brownish
grey much limonite appeared
Gyp. concentrated in slope
wash

12.8 0.3 12.8 - Purple fissile silty
Carbonaceous shale

Overlain by abt 1/2" of lignite

7-12-1



~~4.1~~

Gypsum here in good
QUANTITY

Zone appears DARK
purple in weathered
slope.

13.1

5.1

Dark grey fossil plant
fragment bearing shale
Top. 6" becomes limonite
STAINED. Frags of Monocot.
14.8 Gysiferous efflores-
cence.

CLAY Becoming silty with
occ. silty stringers

Dark Brownish grey

16.5^{3.1} Dark grey limonite
STAINED silty clay.

Gypsum & some plant
frags.

18^{4.9} Olive drab silty clay
with .1' very dark
grey shale with
carb frags.

18.2

3.8

Olive drab silty clay
with 5% mica flocks

pulled 33-36

7-12-1



21' ^(1.4) Olive drab siltstone
with some clay & +
occ. plant frags
Elsewhere at same level
occur ledges of vfy grey
limonite stained ~~edges~~ of
ss. with ^{common} 5% mica &
plant frags on bedding
planes. ^{limonite} thickness
2-6 feet.

22' ^(1.4) ^{some what purple} Dark grey limonite stain-
ed siltstone splinter
with ^{samples of} gypsum.
Some plant remains on
lamination planes. "Blighted
appearance due to gyp."
23' ^(1.4) Gyp. Blotched drop out
siltstone remains clayey
& limonite stained.
& micaceous.

29' 4 covered interval begins

38' 2 lignite + purple ^{brn} lignitic
clays
Top lignite bed ^{low} starts
top of lignite with

7-12-1



gypsum xls.

4.01

3.5

.5' of purple
(fresh) limonite
stained vfg.

MILACIOUS (5-7%)
SS.

40.5

Purple MILACIOUS
(47%) fissile, finely
laminated shale.
Becomes less well
laminated last 1.5'
carries much gyp.
Near ITS upper
CONTACT.



43.5

2.5

Brownish grey BUT
MOTILY BRIGHTLY STAINED
limonite stained
vfg. somewhat MILACIOUS
SANDSTONE.

CONTAINS much gypsum
in crusts & layers

44

Grey fissile gyp
splashed with
limonite stained
silty clay.

46

Covered - Soil.

LOC 7-12-2 ✓ SW $\frac{1}{4}$ SEC 4 T140N R90W
 About 40' Below sec 9 10W
 7-9-1 about $\frac{1}{2}$ mi N.E.
 in drainage

STRIKE on SS

30° 30' NW

Fort Union clays & ss - Small
 frags found

LOC 7-12-3

SW $\frac{1}{4}$ SE $\frac{1}{4}$ SEC 5 T140N R90W

CLAY PIT 14' deep ✓ 20' feet of sec
 bottom 15' white ify ss

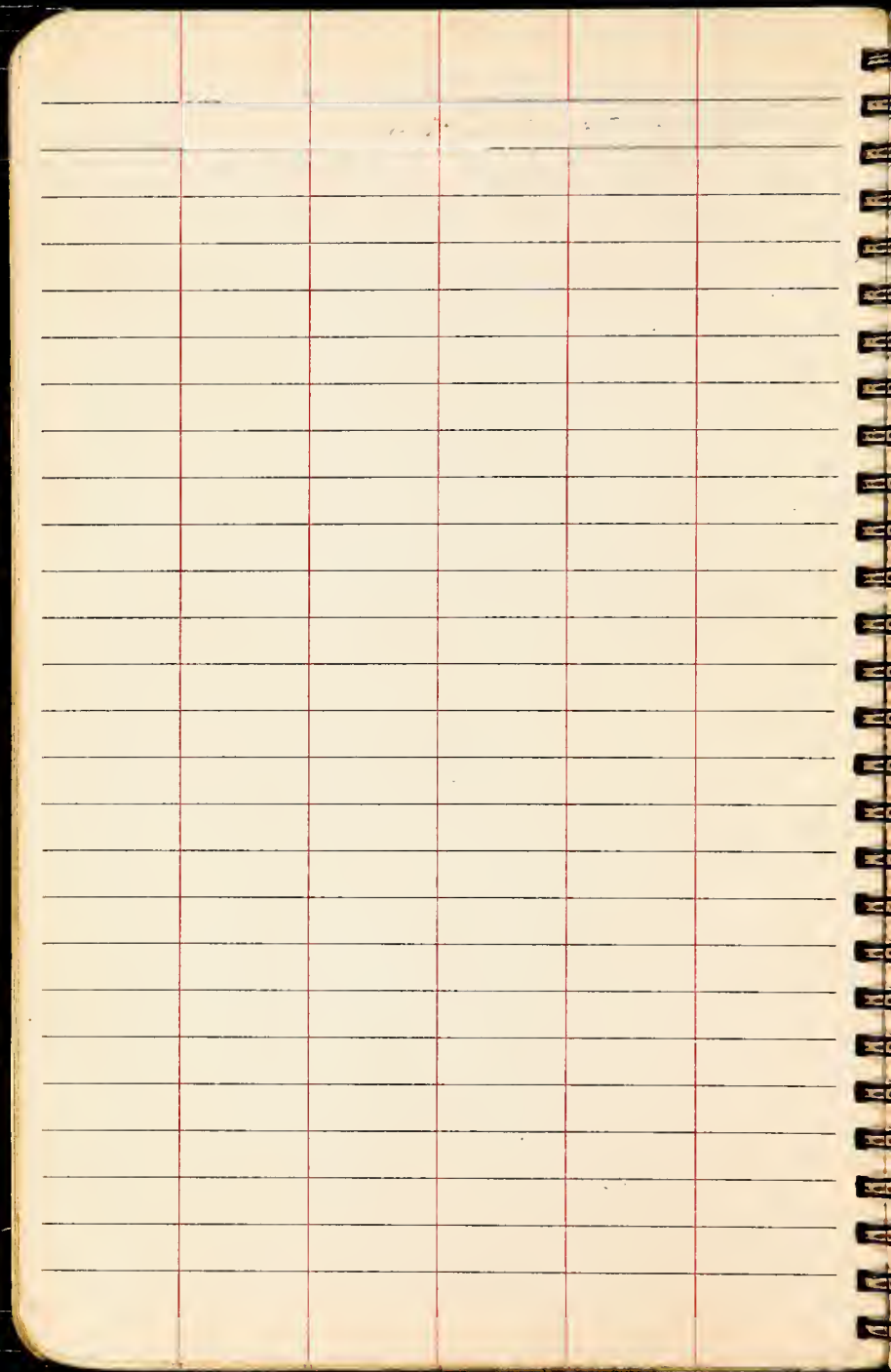
with channels of lignitic purple
 brown siltstone

30' thin ss siltstone as well
 some brown ss with

lignite at the top

25' of yellow lignitic
 stained ss below

which are calcareous



July 15

SECT 7-15-1 CLAY PIT

SE 1/4 Sec 3 T140N R90W

0 3.4 Very light grey siltstone
with purplish brown
channels of siltstone &
abot - AMTS of medium
subang. stringers of sand
& also lignite lenses

Some limonite cones.
steeply dipping bedding
present in the channel

3.4 12.6 Channel begins. siltstone
continues elsewhere.

STR. 117° D 15°N

Blignite in channel
separated by abt 6 in of
SS & siltstones upto 5'

5' Brownish grey
chippy clayey siltstone
with plant frags.

91 DITTO 5' - Plant frags
Some limonite cemented
sand cones

11.9" brownish grey & grey
f.l. sub ang. ss with
plant frags, limonite spots
96yp spots.

7-15-1



Plant frags. inc. upward

14.5" Dark grey siltstone
with plant frags.

15 3/4 ss cmts.

15.3 - Brownish chippy siltstone
with small amt of
ligonite & gyp. xls.

17. 7 Br yellow zone end of
channel & of very light
grey siltstone into which
channel cuts

~~very thin chippy grey &
dark grey silty clay
with carbonaceous matter
& small gyp. xls.~~

3 20 Siltstone becoming more
carbonaceous very dark
gray & very thinly
laminated.

1.5 21.5 very dark grey to blackish
fine laminated silty clay
with carb. & pl. frags.
fossiliferous (piling). ^{fair} leaves
bears 100 ft. S.

7-15-1



24	3.5	~~Very dark grey~~ ^{light} ~~massive~~ ¹⁷⁸ ~~bed~~ ^{stone} MASSIVE. Wh light grey & MASSIVE in outcrop.
270	3.6	Laminated grey to Dr. grey siltstone with carb wood frags.
281	2.7	MASSIVE light grey siltstone
328	0.8	Purple brown laminated siltstone
336	9.9	Very dark grey laminated clayty siltstone. Exps. xls. some limonite staining 35- 40% dark brownish grey med sized gyps. xls. & plant frags. large gyp xls.
435	0.7	fine gr. olive drab - buff K/fan part sand with siltstone frags & carb wood
442	3.1	Grey silty clay rock in a lode with plant stem frags & monocots

7-15-71



47.3 1.7 Black & maroon lignitic clay.
finely laminated ^{Brown steel} _{blue} ^{green} _{black}

48. 0.9 Brown very fissile lignitic
shale with leaf & stem
frags & monocot frags.
Exp. Crusts on bedding.
SALVINIA found. ferns

49.9 1.3 Grey shale plant frags
Some limonite staining.

51.2 13.8 Buff mic cemented
micaceous ^{12-15'} _{sub} ^{fine} _{grained}
limonite stained ^{exp. st.}
SS. Some clay ^{120'}
Silt stone stringers
frags.

Some layers of silt stone
5' 15' easy layer of
micaceous shale
EX 5' silt stone
5' silt stone
5' silt stone
5' silt stone

5.8
5.8

7. - 6.5' - 10' - 12' - 15' - 20' - 25' - 30' - 35' - 40' - 45' - 50' - 55' - 60' - 65' - 70' - 75' - 80' - 85' - 90' - 95' - 100' - 105' - 110' - 115' - 120' - 125' - 130' - 135' - 140' - 145' - 150' - 155' - 160' - 165' - 170' - 175' - 180' - 185' - 190' - 195' - 200' - 205' - 210' - 215' - 220' - 225' - 230' - 235' - 240' - 245' - 250' - 255' - 260' - 265' - 270' - 275' - 280' - 285' - 290' - 295' - 300' - 305' - 310' - 315' - 320' - 325' - 330' - 335' - 340' - 345' - 350' - 355' - 360' - 365' - 370' - 375' - 380' - 385' - 390' - 395' - 400' - 405' - 410' - 415' - 420' - 425' - 430' - 435' - 440' - 445' - 450' - 455' - 460' - 465' - 470' - 475' - 480' - 485' - 490' - 495' - 500' - 505' - 510' - 515' - 520' - 525' - 530' - 535' - 540' - 545' - 550' - 555' - 560' - 565' - 570' - 575' - 580' - 585' - 590' - 595' - 600' - 605' - 610' - 615' - 620' - 625' - 630' - 635' - 640' - 645' - 650' - 655' - 660' - 665' - 670' - 675' - 680' - 685' - 690' - 695' - 700' - 705' - 710' - 715' - 720' - 725' - 730' - 735' - 740' - 745' - 750' - 755' - 760' - 765' - 770' - 775' - 780' - 785' - 790' - 795' - 800' - 805' - 810' - 815' - 820' - 825' - 830' - 835' - 840' - 845' - 850' - 855' - 860' - 865' - 870' - 875' - 880' - 885' - 890' - 895' - 900' - 905' - 910' - 915' - 920' - 925' - 930' - 935' - 940' - 945' - 950' - 955' - 960' - 965' - 970' - 975' - 980' - 985' - 990' - 995' - 1000'

7-15-1



MAADON PARTIAL SS

1.5 58.5 DITTO 51.5 PRECIPIT
NO SALT 6/85

1.5 62 thin layer of 1/4
gray clay + carb plant
frag.

3-62 DITTO 57.1 WITH
rest of carbonate
cemented micaceous
X dotted ss. Some clay
with plant frag.

1.8 62.8 mostly covered
BT fg. Buff micaceous
ss with gyp bloom.

1.7 64.5 ledge of carb cement
and a conc. with
brownish tan.

4.5 36.5 Covered

4.5 1.5 Vis. buff. porous (3-5)
laminated, weakly
cemented gypiferous
somewhat limonite stained
some clay ss

7-15-1



70 17 Dark grey shale or clay
gypsum
some CaCO₃

21.7 3.7 Vfg micaceous (2-3%) buff
limonite stained ss

73 fine grained mica
ss
some clay

54

50.1

JULY 15 BUTTE

SE $\frac{1}{4}$ SE $\frac{1}{4}$ SEC 8 T14N R 90W W $\frac{1}{2}$ - Morton Co.

SEC. D-N-2

H T

Baked Red shale &
silt stone layer
with black sandstone
scoria stone
fossil plant frags in
layer Equisetum -
Layer with distinctive

63 → 14m ~~STP~~ STP coloration
7.2 → covered
8.6 → lignite in slope in plain
9.5 → covered
STP chippy shale

Gypsum

12.5 Grey chippy silty clay
Gyp

14.7 - Clay (grey) with
thin bar bondaceous mottled
outpartings. Some plant
fragments. Becomes much thinner &

15.4 → Grey silty clay (low silt)
weathering orange color
due to limonite

21.11 More silty sandstone

Whole unit weathers orange

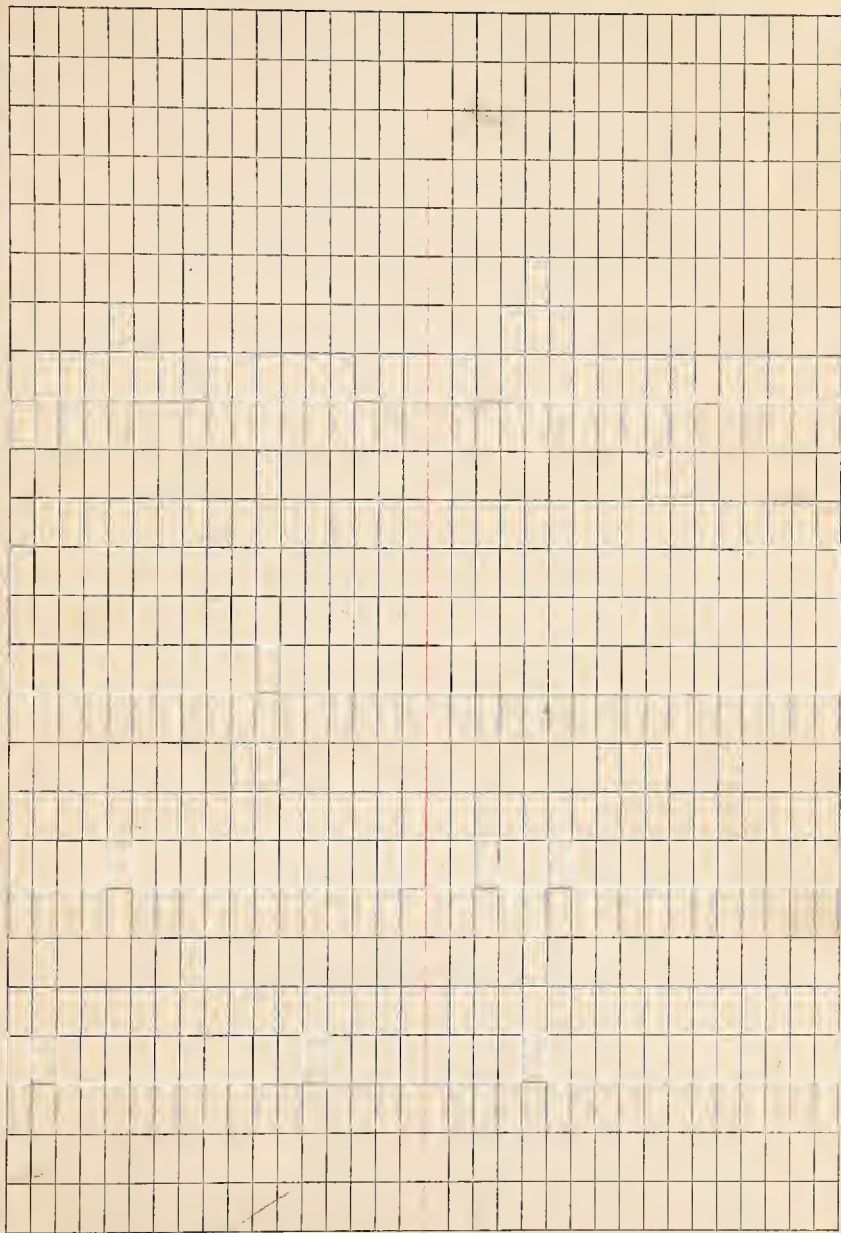
a grey mottled with patches of
cracking.

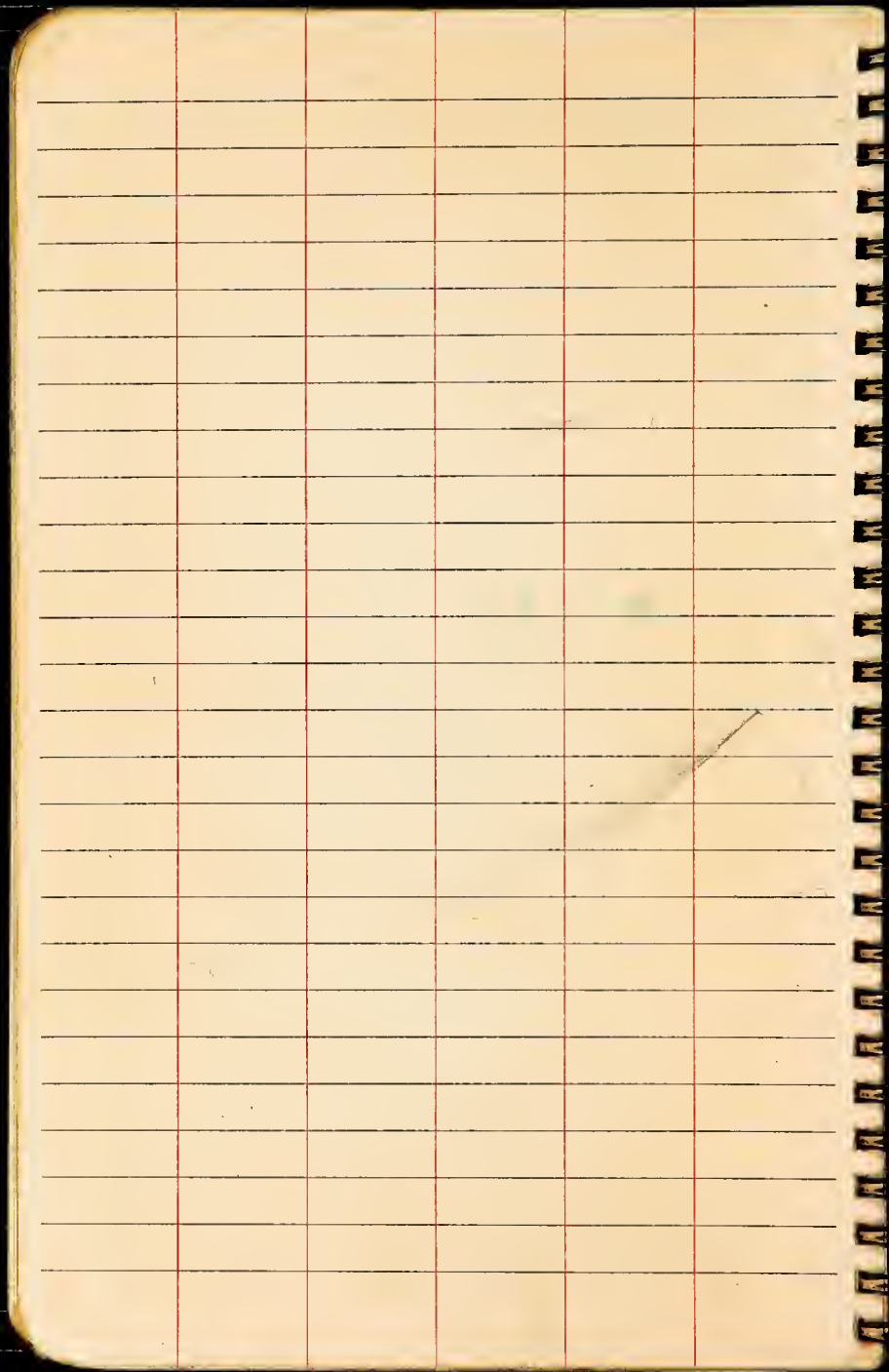
7-15-2.



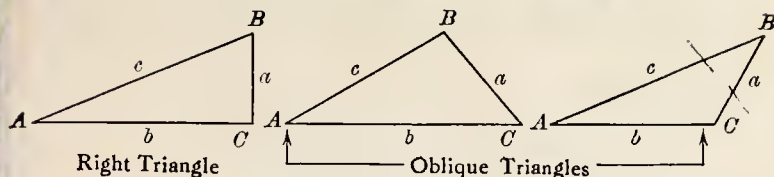
- 24- More silt. ^{small} GYP vis.
- 25- A clayey siltstone
des. as above
small Gypals on surface.
- 30- Darker grey siltstone
orange mottling still pres.
not quite as pronounced.
Gypsum
Turns into a block siltstone
last 6 inches - gradually
Carboniferous plant
remains about 1/2"
on contact between this
unit & one above

325 → Top of section taken
same as 7-16-1





TRIGONOMETRIC FORMULAS



Solution of Right Triangles

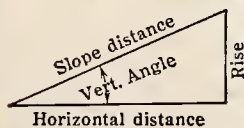
For Angle A. $\sin = \frac{a}{c}$, $\cos = \frac{b}{c}$, $\tan = \frac{a}{b}$, $\cot = \frac{b}{a}$, $\sec = \frac{c}{b}$, $\operatorname{cosec} = \frac{c}{a}$

Given a, b	Required A, B, c	$\tan A = \frac{a}{b} = \cot B, c = \sqrt{a^2 + b^2} = a \sqrt{1 + \frac{b^2}{a^2}}$
a, c	A, B, b	$\sin A = \frac{a}{c} = \cos B, b = \sqrt{(c+a)(c-a)} = c \sqrt{1 - \frac{a^2}{c^2}}$
A, a	B, b, c	$B = 90^\circ - A, b = a \cot A, c = \frac{a}{\sin A}$
A, b	B, a, c	$B = 90^\circ - A, a = b \tan A, c = \frac{b}{\cos A}$
A, c	B, a, b	$B = 90^\circ - A, a = c \sin A, b = c \cos A$

Solution of Oblique Triangles

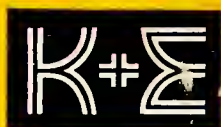
Given A, B, a	Required b, c, C	$b = \frac{a \sin B}{\sin A}, C = 180^\circ - (A + B), c = \frac{a \sin C}{\sin A}$
A, a, b	B, c, C	$\sin B = \frac{b \sin A}{a}, C = 180^\circ - (A + B), c = \frac{a \sin C}{\sin A}$
a, b, C	A, B, c	$A + B = 180^\circ - C, \tan \frac{1}{2}(A - B) = \frac{(a - b) \tan \frac{1}{2}(A + B)}{a + b}$ $c = \frac{a \sin C}{\sin A}$
a, b, c	A, B, C	$s = \frac{a + b + c}{2}, \sin \frac{1}{2}A = \sqrt{\frac{(s - b)(s - c)}{b c}},$ $\sin \frac{1}{2}B = \sqrt{\frac{(s - a)(s - c)}{a c}}, C = 180^\circ - (A + B)$
a, b, c	Area	$s = \frac{a + b + c}{2}, \text{area} = \sqrt{s(s - a)(s - b)(s - c)}$
A, b, c	Area	$\text{area} = \frac{b c \sin A}{2}$
A, B, c, a	Area	$\text{area} = \frac{a^2 \sin B \sin C}{2 \sin A}$

REDUCTION TO HORIZONTAL



Horizontal distance = Slope distance multiplied by the cosine of the vertical angle. Thus: slope distance = 319.4 ft. Vert. angle = $5^\circ 10'$. Since $\cos 5^\circ 10' = .9959$, horizontal distance = $319.4 \times .9959 = 318.09$ ft.
Horizontal distance also = Slope distance minus slope distance times (1 - cosine of vertical angle). With the same figures as in the preceding example, the following result is obtained. $\cos 5^\circ 10' = .9959, 1 - .9959 = .0041, 319.4 \times .0041 = 1.31, 319.4 - 1.31 = 318.09$ ft.

When the rise is known, the horizontal distance is approximately the slope distance less the square of the rise divided by twice the slope distance. Thus: rise = 14 ft., slope distance = 302.6 ft. Horizontal distance = $302.6 - \frac{14 \times 14}{2 \times 302.6} = 302.6 - 0.32 = 302.28$ ft.



No. 360BR

Made in U.S.A.